REMARKS

I. Claim Rejections 35 U.S.C. § 112

Claims 15 and 19 were rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The Examiner asserted that the claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the invention(s), at the time the application was filed, had possession of the claimed invention. The Examiner argued that the "semi-conducting structures" have not been distinctively pointed out to enable one of ordinary skill to know or use the invention. The Examiner further asserted that it is not known whether these are pure semi-conductors, or are doped, or what the intended use or benefits of semi-conducting structures over purely conducting structures are to be considered.

The Applicant respectfully disagrees with this assessment. The Applicant refers to paragraph 0022 of the specification which refers to the example of "semiconducting nanowires" (see last sentence of paragraph 0022). A semiconducting nanowire is a semi-conducting structure. Given that the Applicant's specification provides for plenty of references to nanowires, nanotubes, nanoparticles, and so forth, the Applicant submits that the claim(s) contains subject matter which was described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the invention(s), at the time the application was filed, had possession of the claimed invention. Based on the foregoing, the Applicant submits that the rejection to claims 15 and 19 under 35 U.S.C. 112 has been traversed. The Applicant respectfully requests withdrawal of the aforementioned rejection to claims 15 and 19.

Claim 2 was also rejected under 35 U.S.C. 112, first paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter

which the Applicant regards as the invention. Phraseology contained within lines 3-4 of the pre-grant publication of this application states "such as, for example". The Examiner stated that it is not known if silicon dioxide is a required form of insulation layer, or merely a recitation of a possibility. The Applicant notes that claim 2 as amended now overcomes the rejection under 35 U.S.C. 112.

II. Claim Rejections 35 U.S.C. § 102

Requirements for Prima Facie Anticipation

A general definition of *prima facie* unpatentability is provided at 37 C.F.R. §1.56(b)(2)(ii):

> A *prima facie* case of unpatentability is established when the information *compels a conclusion* that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability. (*emphasis added*)

"Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration." *W.L. Gore & Associates v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303, 313 (Fed. Cir. 1983) (citing *Soundscriber Corp. v. United States*, 360 F.2d 954, 960, 148 USPQ 298, 301 (Ct. Cl.), *adopted*, 149 USPQ 640 (Ct. Cl. 1966)), *cert. denied*, 469 U.S. 851 (1984). Thus, to anticipate the applicants' claims, the reference cited by the Examiner must disclose each element recited therein. "There must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention." *Scripps Clinic & Research Foundation v. Genentech, Inc.*, 927 F.2d 1565, 18 USPQ 2d 1001, 1010 (Fed. Cir. 1991).

To overcome the anticipation rejection, the Applicant needs to only demonstrate that not all elements of a *prima facie* case of anticipation have been met, *i.e.*, show that the prior art reference cited by the Examiner fails to disclose

every element in each of the applicants' claims. "If the examination at the initial state does not produce a prima face case of unpatentability, then without more the applicant is entitled to grant of the patent." *In re Oetiker*, 977 F.2d 1443, 24 USPQ 2d 1443, 1444 (Fed. Cir. 1992).

McHardy

Claims 1, 9-10, and 14 were rejected by the Examiner under 35 U.S.C. 102(b) as being anticipated by McHardy et al (U.S. Patent No. 5315,162), hereinafter referred to as McHardy. The Examiner advised the Applicant to review the entire teaching of McHardy, indicating all of its teaching has been relied upon. When referring to a column and line number of the reference, the Examiner indicated that the following nomenclature is used: CX, LY-Z representing column X, lines Y-Z.

With respect to claim 1, the Examiner argued that McHardy anticipates a physical neural network (citing C 1-6, and C1, L8-10; and C2, L45-54), comprising:

a connection network (NOTE: the Examiner argued that neural networks are inherently a connection network, as proper operation requires numerous weighted connections and other requirements) comprising a plurality of molecular conducting connections suspended within a connection gap (citing C 3, L43-45) formed between at least one input electrode and at least one output electrode (citing C 1-6, particularly C1, L44 through C2, 54; where the Examiner argued that it discusses the roles of the anode and the cathode), wherein at least one molecular connection of said plurality of molecular conducting connections can be strengthened or weakened according to an application of an electric field across said connection gap (citing C 1-6, particularly C1, L44 through C 2, L54; C3, L44 through C 4, L 7; arguing strengthening or weakening corresponds to the amount of whiskers in the interconnect channel, asserting that likewise the conductivity of that channel; and

a plurality of physical synapses formed from said molecular conducting connections of said connection network (citing C 1-6, particularly C 2, L45-54).

The Applicant respectfully disagrees with this assessment. Applicant's amended claim 1 teaches a physical neural network based on molecular technology (e.g., nanotechnology), including a connection network comprising a plurality of molecular conducting connections suspended in a solution within a connection gap formed between at least one input electrode and at least one output electrode, wherein at least one molecular connection of said plurality of molecular conducting connections can be strengthened or weakened according to an application of an electric field across said connection gap. C 3, L 42-45 of McHardy does not refer to such a connection network; neither does C 3, L43-45; C 1-6, particularly C1, L44 through C2, 54, or C 1-6, particularly C1, L44 through C 2, L54; C3, L44 through C 4, L 7 of McHardy. McHardy particularly does not teach a physical neural network based on <u>nanotechnology</u>.

Considerably more important, however, is a misunderstanding of the physical mechanism that is being used to construct artificial synapses. The Examiner has stated that "the entire teachings [of McHardy] have been relied upon". Based on this statement it is clear that the Examiner has not understood the teachings outlined by Applicant's specification and claims. We will review the differences clearing order to clarify and distinguish the Applicant's invention. The synapse, as described by the Applicant's specification and claims, utilizes an electro**<u>mechanical</u>** aggregation of <u>nanoparticles</u> by dipole-induced forces. For example, refer to paragraph [0098] of Applicant's specification where the Applicant indicates that "...a dipole should preferably be induced in the material when in the presence of an electric field". To this end, Applicant's claims have been amended to refer to clarify a "dipole-induced connection network" rather than simply a "connection network". The effect relies on an electrode gap with **no pre-existing connection** between the two terminals. When a voltage is applied across the terminals, an

inhomogeneous electric field induces a dipole in nanoparticles suspended in the liquid near the electrode gap. The induced dipole in turn induces a force toward the direction of increasing field gradient and draws the nanoparticles into the connection gap to form a connection. The effect DOES NOT rely on the formation of ions.

McHardy, by stark contrast, requires a "permanent interconnection forms an electrolytic path between the input terminal and output terminal. The **permanent interconnect** has a small, but finite conductivity." (see Detailed Description, Paragraph 1 of McHardy). Note that this configuration does not describe the Applicant's invention because the Applicant does not utilize a permanent interconnect. McHardy claims that "Preferably, the spacing between the input terminal 12 and output terminal 14 will be on the order of 5-10 microns." Again, this in stark contrast with the Applicant's invention, in which the connection gap distance is considerably less that 1 micron. Further, McHardy teaches the following:

> "The precipitation of copper occurs because of pH changes associated with parallel electrode reactions involving the water present in the electrolytic solution provided by the absorbed moisture. Under the influence of an applied voltage, the water reacts at the anode to yield oxygen and hydrogen ions (acid) and at the cathode to yield hydrogen gas and hydroxyl ions (base).
>
> The solubility of copper ions decreases as the pH rises, so that they remain in solution only in a narrow zone close to the anode. As the copper ions migrate into the more neutral electrolyte displaced away from the anode, the copper ions precipitate as the low-density oxide filaments. The spongy oxide product fills the narrow gap to the anode so that the filaments appear to grow directly from the anode.
>
> The copper oxide whiskers grow preferentially along pre-existing paths. This preferred growth path is believed to be due to the hygroscopic nature of copper oxide which would tend to enhance the absorption of moisture. Once a copper oxide whisker connects the two electrodes, the resistance falls progressively with time. This fact, coupled with the controlling influence of pH, provides a capability for controlling whisker growth and removal."

It should be noted that **the invention disclosed and claimed by the Applicant does not utilize an electrochemical process.** The entire effect of McHardy requires the migration of metal **ions.** Note that ions **cannot be used** in Applicant's invention. If ions were used, electrophoresis would preferentially deposit the ions on either the anode or the cathode (depending on the ion charge). To demonstrate even more dramatically the difference between McHardy and the present invention, note that the Applicant has disclosed the use of an alternating electric field to be used across the electrode gap: "When an alternating voltage is applied to the electrodes, thin metallic fibers begin to grow on the electrode edge facing the gap." This should not be taken lightly, as a pure electrophoretic force, as described by McHardy, would fail completely when exposed to an alternating field since the particles would be attracted and repelled equally to both electrodes. This effect can be understood in light of a **dipole-induced force**, and it is such a force that can be utilized by the Applicant's invention.

Based on the foregoing, the Applicant submits that the rejection to claim 1 fails under the aforementioned prima facie anticipation test. That is, McHardy fails to disclose each and every element in Applicant's claim 1. The Applicant reminds the Examiner that in order to succeed in a rejection to a claim under 35 U.S.C. 102 based on a cited reference, that cited reference (in this case, McHardy), must disclose each and every claim limitation of the rejected claim. If even one claim limitation, however minor, is missing from the cited reference, then the rejection fails under 35 U.S.C. 102. In the present rejection, McHardy does not teach a physical neural network based on nanotechnology as the term "nanotechnology" is taught by Applicant's invention. McHardy further does not teach <u>nanometer-scale</u> devices and components. McHardy also does not provide for any teaching of a dipole-induced connection network made up of neural connections formed in a <u>solution</u>. The Applicant therefore submits that the rejection to claim 1 under 35

U.S.C. 102 has been traversed. The Applicant respectfully requests withdrawal of the rejection to claim 1.

Regarding claim 9, the Examiner argued McHardy anticipates the physical neural network of claim 1 wherein said at least one input electrode comprises a pre-synaptic electrode and said at least one output electrode comprises a post-synaptic electrode. In support of this argument, the Examiner cited C 1-6, and particularly C 3, L 44-62 of McHardy, which states the following:

> "The present invention involves solid-state, electrochemical synapses which are adapted for use in neural networks. A preferred exemplary electrochemical synapse in accordance with the present invention is shown generally at 10 in FIG. 1. The electrochemical synapse includes an input terminal 12, an output terminal 14, and a permanent interconnect 16 located therebetween. The permanent interconnect 16 forms an electrolytic path between the input terminal 12 and output terminal 14. The permanent interconnect has a small, but finite conductivity. The input terminal 12 and output terminal 14 are spaced apart a distance of less than 100 microns. Preferably, the spacing between the input terminal 12 and output terminal 14 will be on the order of 5-10 microns. A DC voltage is provided across the permanent interconnect 16 by voltage source 18 which is connected to the input terminal 12 and output terminal 14 by way of electrical connections 20 and 22, respectively."

The Applicant respectfully disagrees with this assessment and notes the arguments presented above against the rejection to claim 1 apply equally against the rejection to claim 9. The language of C 3, L 44-62 of McHardy does not provide for any disclosure of a connection formed from dipole induced aggregation of nanoparticles. Additionally, McHardy points out that "preferably, the spacing between the input terminal 12 and output terminal 14 will be on the order of 5-10 microns". 5-10 microns are <u>not</u> nanometer-scale dimensions, and hence the entire citation of C 3, L 44-62 of McHardy fails to disclose <u>nanotechnology</u> as <u>taught</u> by <u>Applicant's invention</u>.

Claim 9 teaches nanotechnology based claim limitations, each which are not taught, suggested or disclosed by the McHardy reference.

Based on the foregoing, the Applicant submits that the rejection to claim 9 fails under the aforementioned prima facie anticipation test. That is, McHardy fails to disclose each and every element in Applicant's claim 9. The Applicant therefore

submits that the rejection to claim 9 under 35 U.S.C. 102 has been traversed. The Applicant respectfully requests withdrawal of the rejection to claim 9.

Regarding claim 10, the Examiner argued that McHardy anticipates the physical neural network of claim 9 wherein a resistance of said molecular conducting connections bridging said at least one pre-synaptic electrode and said at least one post-synaptic electrode is a function of a prior electric field across said at least one pre-synaptic electrode and said at least post-synaptic electrode. In support of this argument, the Examiner cited C 1, L 29 through C 2, L 4 of McHardy, where McHardy discusses Bernard Widrow's "memistor's" capability to regulate resistance (asserting that it does this through the application of an electric field) and also immediately following the discussion where it describes the process of metal migration, and how metallic whiskers grow to create an ohmic [resistive] contact between electrodes when a DC voltage is applied, arguing the whiskers being the molecular conducting connections.

The Applicant respectfully disagrees with this assessment and notes the arguments presented above against the rejection to claim 1 apply equally against the rejection to claim 10. Thus, as indicated above, McHardy does not teach, disclose or suggest nanotechnology as taught by Applicant's invention, but instead focuses on micron scale devices and components. McHardy does not provide any teaching of nanometer-scale devices or components. Additionally, McHardy does not provide any teaching of a connection formed from dipole induced aggregation of nanoparticles. Indeed, a connection forming from an electrochemical process is completely different than a dipole-induce force and results in completely different operating parameters

Applicant's claim 10 indicates a <u>resistance</u> of said <u>molecular</u> conducting connections bridging said at least one pre-synaptic electrode and said at least one post-synaptic electrode is a <u>function</u> of a <u>prior electric field</u> across said at least one pre-synaptic electrode and said at least post-synaptic electrode.

C 1, L 29 through C 2, L 4 and the discussion of a "memistor" provides no disclosure, or teaching of a resistance, molecular conducting connections, one or more pre-synaptic electrodes, one or more post-synaptic electrodes, and wherein the resistance that is a function or a prior-electric field, all in the context of a neural network based on nanotechnology. Instead, C 1, L 29 through C 2, L 4 of McHardy discloses the following:

> "An electrochemically regulated synapse known as the "Memistor" was developed in the 1960's by Bernard Widrow, as part of a network known as the "Adaline" network, as disclosed by B. Widrow, in the publication "Neural Network Theory, Past and Present," Paper presented at the DARPA Neural Network Study Symposium, Lincoln Labs, 1987. The Memistor is an electrochemical cell in which copper is either plated on or deplated from a carbon rod. As a result of the controlled plating and deplating of copper, the resistance of the rod is continuously adjustable from 1-10 ohms. This provides a 10:1 range of synaptic "weights." The Memistor serves well from the standpoint of trainability, surviving numerous plating and deplating cycles. **However, the Memistor does not lend itself to miniaturization and the device is not practical for large-scale networks.**
>
> Metal migration is an **electrochemical process related to electroplating**. Metal migration takes place between conductors in an active electronic circuit in the presence of a **moisture film.** Under the influence of a DC voltage, metal ions dissolve from the positive conductor (the anode). The **dissolved ions** migrate through the moisture film (the electrolyte) and plate out on the negative conductor (the cathode). The deposit often takes the form of metallic whiskers which eventually reach the anode and create an ohmic contact.
>
> Metal migration has been observed with all of the metals commonly used in the electronics industry, but it occurs most readily with silver (see A. Dermarderosian, "The Electrochemical Migration of Metals," Proc. 1978 Microelectronics Symp., 134-141, International Soc. for Hybrid Microelectronics, 1978). The minimum or "critical" voltage V_c required to grow metallic whiskers can range from a few millivolts to over 2 volts, depending on the metal and prevailing conditions surrounding the electronic circuit. Once V_c is exceeded, growth rates tend to increase linearly with ($V- V_c$) (see P. B. Price, et al., "On the Growth Properties of Electrolytic Whiskers," ACTA Met., 6, 1968). The initial contact resistance is typically in the range of 10^4 -10^6 ohms, but with continued whisker growth, the contact resistance falls several orders of magnitude."

It is interesting to note that McHardy indicates that the "memistor" does not lend itself to miniaturization (see bolded above). Thus the memistor described above is ill suited for applicability to nanotechnology-based neural networks. Thus, the Examiner's arguments that a "memistor" is capable of regulating resistance in the context of the nanotechnology-based neural network of Applicant's invention

are incorrect, simply because nanotechnology involves "miniaturization". Additionally, the process of metal migration, and how metallic whiskers grow to create an ohmic resistance, etc., also do not provide for any teaching of pre-synaptic and post-synaptic electrodes in the context of a nanotechnology-based neural network. The Applicant's invention requires the dipole-induced assembly of nanoparticles from a liquid suspension (not a moisture film) and **does not utilize ions.**

Based on the foregoing, the Applicant submits that the rejection to claim 9 fails under the aforementioned prima facie anticipation test. That is, McHardy fails to disclose each and every element in Applicant's claim 10. The Applicant therefore submits that the rejection to claim 10 under 35 U.S.C. 102 has been traversed. The Applicant respectfully requests withdrawal of the rejection to claim 10.

Regarding claim 14, the Examiner argued that McHardy anticipates the physical neural network of claim 1, wherein said molecular electrically conducting connections comprise molecular conducting structures suspended within a non-electrically conducting solution. In support of this argument, the Examiner cited C 6, L 30-46 of McHardy, and asserted that a non-electrically conducting solution is described in McHardy as multi-layer thin film technology utilizing polymer dielectrics.

The Applicant respectfully disagrees with this assessment and notes the arguments presented above against the rejection to claim 1 apply equally against the rejection to claim 14. C 6, L 30-46 of McHardy does not describe molecular electrically conducting connections comprise molecular conducting structures suspended within a non-electrically conducting solution. The solution of Applicant's claim 14 is utilized as the medium for forming nanoconnections. Instead, C 6, L 30-46 of McHardy indicates that the connections of McHardy made with plated through holes (see C 6, L 38-40 of McHardy). There is no discussion in C 6, L 30-46 of McHardy of molecular electrically conducting connections comprise molecular

conducting structures suspended within a non-electrically conducting solution. Multi-layer thin film technology and polymer dielectrics do not provide any teaching or disclosure of molecular electrically conducting connections comprise molecular conducting structures suspended within a non-electrically conducting solution. The Examiner has made a statement that is so without elaborating on how and why this is so. How is a polymer dielectric a liquid?

The Applicant also notes that claim 14 as amended teaches the following claim limitations: the physical neural network of claim 1 wherein said molecular electrically conducting connections comprise molecular electrically conducting structures suspended <u>and free to move about</u> within said solution, said solution comprising a non-electrically conducting solution. The feature "free to move about" is not disclosed by McHardy.

Based on the foregoing, the Applicant submits that the rejection to claim 9 fails under the aforementioned prima facie anticipation test. That is, McHardy fails to disclose each and every element in Applicant's claim 14. The Applicant therefore submits that the rejection to claim 14 under 35 U.S.C. 102 has been traversed. The Applicant respectfully requests withdrawal of the rejection to claim 14.

III. Claim Rejections – 35 U.S.C. § 103

Requirements for Prima Facie Obviousness

The obligation of the examiner to go forward and produce reasoning and evidence in support of obviousness is clearly defined at M.P.E.P. §2142:

> The examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. If the examiner does not produce a *prima facie* case, the applicant is under no obligation to submit evidence of nonobviousness.

M.P.E.P. §2143 sets out the three basic criteria that a patent examiner must satisfy to establish a *prima facie* case of obviousness:

1. some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings;

2. a reasonable expectation of success; and

3. the teaching or suggestion of all the claim limitations by the prior art reference (or references when combined).

It follows that in the absence of such a *prima facie* showing of obviousness by the Examiner (assuming there are no objections or other grounds for rejection), an applicant is entitled to grant of a patent. *In re Oetiker*, 977 F.2d 1443, 1445, 24 USPQ2d 1443 (Fed. Cir. 1992). Thus, in order to support an obviousness rejection, the Examiner is obliged to produce evidence compelling a conclusion that each of the three aforementioned basic criteria has been met.

McHardy, Gorelik

Claims 2-8 were rejected by the Examiner under 35 U.S.C. 103(a) as being unpatentable over McHardy as applied to claim 1 above, and further in view of Gorelik (U.S. Patent No. 5,864,835).

Regarding claim 2, the Examiner admitted that McHardy fails to teach wherein the physical neural network further comprises a gate located adjacent said connection gap, insulated from electrical contact by an insulation layer. The Examiner argued, however, that Gorelik teaches wherein the physical neural network further comprises a gate located adjacent said connection gap, insulated from electrical contact by an insulation layer (citing Gorelik: C 8 L 54 through C 9, L 35).

The Examiner asserted that being from the same field of endeavor, physical neurons (of artificial neuron systems) and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's electrochemical synapse asserting that this provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Gorelick's semi conducting method of an approximation to an artificial biological neuron with this insulation layer so as to maintain charge within the charge carrying layer indefinitely, thereby allowing minimal leakage. In support of this argument, the Examiner cited Gorelik: C 8 L 54 through C 9, L 35). The Examiner argued that combining the electrochemical synapse with a semi conducting signaling device allows for greater flexibility in the application of the physical neural network, where it is to be implemented in different environments for different needs of fault-tolerance or physical structure or electrical requirements.

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 apply equally against the rejection to claim 2 under 35 U.S.C. 103. Thus, as indicated earlier, McHardy does not disclose, teach or suggest nanotechnology as taught by Applicant's invention due to the fact that McHardy focuses on micron level components and fabrication techniques and in fact relies on an entirely different physical process to construct synaptic connections. Similarly, Gorelik does not provide any teaching of nanotechnology and more particularly, nanotechnology based physical neural networks. C 8 L 54 through C 9, L 35 of Gorelik in particular cited by the Examiner does not provide for any teach of nanotechnology. Instead, C 8 L 54 through C 9, L 35 of Gorelik teaches the use of CMOS technology and various logic gates and semiconductor components commonly used in standard semiconductor fabrication processes, but does not provide for any teaching of nanometer-scale components and nanometer-scale device fabrication processes.

Additionally, the Examiner is incurred that the cited references are from the same field of endeavor, arguing that this field is physical neurons (of artificial neuron systems) and synapses to mimic the behavior of biological neurons. Based on the foregoing, the Applicant submits that the rejection to claim 2 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 2, including all of the claim limitations of the claim(s) from which claim 2 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that neither Gorelik nor McHardy provide any teaching or suggestion of molecular technology, including nanotechnology. Third, there is simply no teaching of all the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 2 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's

invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 2 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 2.

Regarding claim 3, the Examiner argued that McHardy teaches that the gate of the physical neural network of claim 2 is connected to logic circuitry which can activate or deactivate individual physical synapses among said plurality of physical synapses. In support of this argument, the Examiner cited McHardy: C 1-6, particularly C 4, L 55 through C 5, L 9; and asserted that some control mechanism is inherent to controlling this controlled forgetfulness as applied to "specific synaptic connections".

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 apply equally against the rejection to claim 3 under 35 U.S.C. 103. Additionally, the Applicant submits that the arguments presented above against the rejection to claim 2 apply equally against the rejection to claim 3.

The Applicant submits that the rejection to claim 3 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 3, including all of the claim limitations of the claim(s) from which claim 3 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that neither Gorelik nor McHardy provide any teaching or suggestion of molecular technology, including nanotechnology and especially dipole-induced aggregation of nanoparticles upon

which the Applicant's claims are based. Third, there is simply no teaching of all the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 3 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Finally, it appears from the Examiner's comments that the Examiner has misunderstood the function of the gate and its role in activating and deactivating the synapse. The ability to control a connection with an external gate, as utilized by the Applicant's invention, has nothing to do with adapting the synaptic strength but rather turning the connections on or off. The adaptation of the connection is controlled by pre-and post-synaptic electrode activity. The gate is utilized in the context of a very large neural network to selectively deactivate certain connections so as to evolve network **topologies**, not connection weights. Where in McHardy is it shown that the synaptic elements can be both modified **and** selectively activated and deactivated? McHardy is simply concerned with the ability to weaken a

connection element. The gate and semi-conducting particles, as described by the Applicant, is concern with turning the connection on and off, but not update or modifying, the connection.

Based on the foregoing, the Applicant submits that the rejection to claim 3 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 3.

Regarding claim 4, the Examiner argued that McHardy teaches the physical neural network of claim 2 wherein said gate is connected to logic circuitry which can activate or deactivate groups of physical synapses of said plurality of physical synapses. In support of this argument, the Examiner cited McHardy: C 1-6, particularly C 4, L 55 through C 5, L 9; and argued that some control mechanism is inherent to controlling this "controlled forgetfulness" as applied to a "low level back bias to all connections," constituting a group.

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 apply equally against the rejection to claim 4 under 35 U.S.C. 103. Additionally, the Applicant submits that the arguments presented above against the rejection to claim 2 apply equally against the rejection to claim 4.

The ability to control a connection with an external gate, as utilized by the Applicant in the present invention, has nothing to do with adapting the synaptic strength but rather turning the connections on or off. The adaptation of the connection is controlled by pre-and post-synaptic electrode activity. The gate is utilized in the context of a very large neural network to selectively deactivate certain connections so as to evolve network **topologies**, not connection weights. Where in McHardy is it shown that the synaptic elements can be both modified **and** selectively activated and deactivated? McHardy is simply concerned with the ability to weaken a connection element. The gate and semi-conducting particles, as

described by the Applicant, is concern with turning the connection on and off, but not updating or modifying, the connection.

The Applicant submits that the rejection to claim 4 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 4, including all of the claim limitations of the claim(s) from which claim 4 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that neither Gorelik nor McHardy provide any teaching or suggestion of molecular technology, including nanotechnology. Third, there is simply no teaching of all the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 4 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 4 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 4.

Regarding claim 5, the Examiner admitted that McHardy fails to teach that the molecular conducting connections comprise semi-conducting molecular structures. The Examiner stated that they are purely conducting structures in McHardy.

The Examiner asserted that Gorelik teaches wherein the molecular conducting connections comprise semi-conducting molecular structures. In support of this argument, the Examiner cited Gorelik, C 8 L 54 through C 10 L 63, where it discusses the charge carrying semiconductor device, which comprises semi-conducting molecular connections.

The Examiner argued that it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's and Gorelik's invention for the reasons stated above (citing section, regarding claim 2).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 apply equally against the rejection to claim 5 under 35 U.S.C. 103.

The Applicant submits that the rejection to claim 5 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 5, including all of the claim limitations of the claim(s) from which claim 5 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that neither Gorelik nor McHardy provide any teaching or suggestion of molecular technology, including nanotechnology and also the dipole-induced aggregation of nanoparticles. Third,

there is simply no teaching of all the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 5under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

As a final note, it appears the Examiner has attempted to apply the **neural node** described by Gorelik to the **synapse element** described by McHardy. A neuron is not a synapse.

Based on the foregoing, the Applicant submits that the rejection to claim 5 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 5.

Regarding claim 6, the Examiner admitted that McHardy fails to teach that the semi-conducting molecular structures comprise semi-conducting nanotubes. The Examiner argued that Gorelik teaches wherein the semi-conducting molecular structures comprise semi-conducting nanotubes. In support of this argument, the

Examiner cited Gorelik, C 8 L 54 through C 10, L 63, where it discusses the charge carrying semiconductor device, which comprises semi-conducting molecular connections. The Examiner therefore asserted that it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's and Gorelik's invention for the reasons stated above (referring to "regarding claim 2").

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 apply equally against the rejection to claim 6 under 35 U.S.C. 103. The Applicant also submits that all of the arguments against the rejection to claim 5 apply equally to the rejection to claim 6.

Regarding the Examiner's arguments that C 8 L 54 through C 10, L 63 of Gorelik teaches nanotubes, the Applicant has reviewed this citation and the rest of Gorelik and cannot find any mention of nanotubes as taught by Applicant's invention. Nanotubes are devices based on molecular technology (e.g., nanotechnology) as taught by Applicant's invention. A portion of C 8 L 54 through C 10, L 63 of Gorelik is reproduced as follows below:

"Having now described some fundamentals of artificial neural networks that are known in the prior art, reference is now made to FIGS. 3A and 3B, which illustrate the principal components of semiconductor device (generally designated as reference numeral 100) that simulates a biological neuron. FIG. 3A is a diagram that schematically illustrates the device 100, while FIG. 3B is a diagram that illustrates a cross-sectional representation of a semiconductor material. In accordance with the preferred embodiment of the present invention, a charge-carrying semiconductor device (CCSD) 102 is fabricated from semiconductor material (such as a polysilicon) and is disposed above a semiconductor substrate 103, for example a P-type substrate. The charge-carrying semiconductor device 102 is separated from the substrate 103, and substantially surrounded, by an isolating material, such as an oxide. Silicon dioxide (SiO.sub.2)or silicon nitride (Si.sub.3 N.sub.4) are examples of oxides commonly used for this purpose. Advantageously, the substantial isolation of the CCSD 102 helps ensure the preservation of electrical charge on the CCSD 102. Indeed, in accordance with a preferred embodiment, virtually no charge leakage occurs, and absent purposeful charge injection or drainage (described below), the charge deposited on the charge carrying component will be preserved virtually indefinitely (for all practical purposes).

Indeed, the operation of device 100 is based on the ability of free charge to be preserved within the structure for a very long time. Free charge carriers can be introduced by either doping or from external sources. Charge can be introduced via hot electron

injection through a thin tunneling-oxide into the CCSD 102 or removed by electron tunneling from the structure to the underlying substrate 103. These two processes can be controlled by applying appropriate potentials to gates 108 and 112 located above the injector 1 10 and drain 114 nodes respectively. These nodes can be formed by conventional MOS transistors or by other means such as a single-transistor silicon synapse. Once charge is resident on the CCSD 102 it will disperse evenly throughout the CCSD 102.

Various electrodes and gates, such as gates 108 and 112, will be referred to herein as being displaced adjacent to or in proximity with the CCSD 102. It will be appreciated that the terms `adjacent` and `proximity`, are relative terms that necessarily depend upon the operation performed thereby. For example, in regard to the charge injector 104, the gates are spaced from the CCSD 102 by an oxide layer, which is thin enough to permit the transfer of charge carriers (either P-type or N-type) from the well 110 to the CCSD 102, in response to potential applied to the control gate 108.

To more particularly describe the injection and removal of charge to/from the CCSD 102, in order to control the quantity of charge carried on the charge-carrying component, a charge injector 104 is disposed adjacent to the CCSD 102 and is configured to controllably transfer charge to the CCSD 102 from an external source (not shown). Similarly, a drain 106 disposed adjacent to the CCSD 102 and is configured to controllably transfer charge away from the CCSD 102. The charge injector 104 and drain 106 of the preferred embodiment of the present invention are structurally similar to charge injectors and drains conventionally used in EEPROM technology.

The charge injector 104 includes a control gate 108 and a transistor 110, such as a MOSFET, disposed opposite the CCSD 102. The transistor 110 may be formed from a P-type well, with N-type material implanted, as illustrated in FIG. 3B. Applying an appropriate potential to the control gate 108 causes the transistor 110 to transfer charge (through hot electron injection) through the oxide layer surrounding the CCSD 102, to the CCSD. Similarly, a second control gate 112 is disposed in connection with the drain 106, wherein the application of a control potential to the control gate 112 control the operation of a drain transistor 114. Thus, through tunneling or otherwise, this causes charge accumulated and carried on the CCSD to be transferred away, by way of the drain transistor 114. The drain transistor 114 may be formed by an N-type well, with P-type materials implanted therein, as illustrated. Again, the basic structure and operation relating to the charge injection and charge drainage to/from the CCSD 102 is similar to that utilized in EEPROM technology, and for that reason it need not be further described herein.

To generate an output (simulating an axon), a charge sensor 116 disposed in proximity with a charge sensing location on the CCSD, and an output is provided and disposed in communication with the charge sensor. In practice, the charge sensor 116 may be implemented as a transistor that is responsive to charge concentrated in the charge sensing location. In this regard, the charge sensing location will operate much like the control gate 108 and 112 in operating transistors 110 and 114. As a result, the output delivers an electric signal that is indicative of the charge sensed by the charge sensor 116.

Although the structure, technology, and fabrication techniques of the CCSD 102, the charge injector 104 and the drain 106 of the preferred embodiment are similar to those implemented EEPROM devices, the relative size of the CCSD 102, in comparison to surrounding devices (which will be discussed below) is much larger than the relative size proportion of an EEPROM. As will be more fully appreciated from the discussion that follows, the relatively large size of the CCSD 102 allows for controlled redistribution of the charge carried by the CCSD 102, in response to localized electric fields created by input devices,

which simulate the input stimulus of synapses and synaptic sites of a biological neuron. Thus, the redistribution of electric charge carried on the CCSD 102 will necessarily effect the concentration of charge in the charge sensing location, and thus the output generated by the charge sensing node 116.

To illustrate one structural adaptation of the CCSD 102 and a configuration of synaptic inputs, reference is hereby made to FIG. 4. In this illustrated embodiment, the CCSD 102 is U-shaped and includes a plurality of synaptic sites 120. Each synaptic site 120 includes an input 122 and a weighting function or weighting coefficient 124. A preferred structure of various inputs 122 will be described in FIGS. 5A, 5B, and 5C. Suffice it to say that, for purposes of the inventive concepts disclosed herein, the present invention is not limited to a particular input device or structure. Also illustrated is the charge sensor 116, which is used to generate the output signal that is delivered via output 130.

Each of the various inputs 122 are derived either from system inputs, or from outputs of neighboring devices 100 (See processing elements 20 of FIG. 2). As previously mentioned, and as is generally known, the weighting function associated with a given input 122 alters the effect of that input 122. In this regard, a given weighting function may nullify a given input, by weighting it with a value of zero. Furthermore, the various weighting functions may be varied over time, as the device 100 is trained (e.g., simulated learning).

In operation, charge is delivered from the charge injector 104 to the CCSD 102. If all weighting functions/coefficients 124 are set to zero, such that no input is effective upon the CCSD 102, then the charge carried on the CCSD 102 will evenly distribute itself throughout the surface of the CCSD 102. However, as various inputs 122 are imparted (as electric fields)upon local areas of the CCSD 102, they will redistribute the charge in that local area, which will affect the overall distribution of charge. Thus, although the overall quantity of charge carried on the CCSD 102 may be constant, various changes in the inputs 122 and input weighting coefficients will affect the output, as sensed by sensor 116 and delivered to output (axon) 130."

The language reproduced above from Gorelik provides absolutely no teaching or suggestion of nanotubes as taught by Applicant's invention. Nanotubes are a fundamental claim limitation of Applicant's claim 6. Where are nanotubes taught by Gorelik? Beyond this, it should also be noted that Gorelik is attempting to mimic a neuron and the applicant is describing a synapse element. A synapse is not a neuron.

The Applicant submits that the rejection to claim 6 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's

claim 6, including all of the claim limitations of the claim(s) from which claim 6 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that neither Gorelik nor McHardy provide any teaching or suggestion of molecular technology, including nanotechnology. Third, there is simply no teaching of all the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 6 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 6 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 6.

Regarding claim 7, the Examiner admitted that McHardy fails to teach that the semi-conducting molecular structures comprise semi-conducting nanowires. The Examiner argued that Gorelik teaches wherein the semi-conducting molecular

structures comprise semi-conducting nanowires. In support of this argument, the Examiner cited Gorelik, C 8 L 54 through C 10, L 63, where it discusses the charge carrying semiconductor device, which comprises semi-conducting molecular connections.

The Examiner asserted that it would have been obvious to one of ordinary skill at the time of the Applicant's invention to combine McHardy's and Gorelik's invention for the reasons stated above (referring to "regarding claim 2).

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 apply equally against the rejection to claim 7 under 35 U.S.C. 103. The Applicant also submits that all of the arguments against the rejection to claim 5 apply equally to the rejection to claim 7.

Regarding the Examiner's arguments that C 8 L 54 through C 10, L 63 of Gorelik teaches nanowires, the Applicant has reviewed this citation and the rest of Gorelik and cannot find any mention of nanowires as taught by Applicant's invention. Nanowires are devices based on molecular technology (e.g., nanotechnology) as taught by Applicant's invention. A portion of C 8 L 54 through C 10, L 63 of Gorelik is reproduced as follows below:

"Having now described some fundamentals of artificial neural networks that are known in the prior art, reference is now made to FIGS. 3A and 3B, which illustrate the principal components of semiconductor device (generally designated as reference numeral 100) that simulates a biological neuron. FIG. 3A is a diagram that schematically illustrates the device 100, while FIG. 3B is a diagram that illustrates a cross-sectional representation of a semiconductor material. In accordance with the preferred embodiment of the present invention, a charge-carrying semiconductor device (CCSD) 102 is fabricated from semiconductor material (such as a polysilicon) and is disposed above a semiconductor substrate 103, for example a P-type substrate. The charge-carrying semiconductor device 102 is separated from the substrate 103, and substantially surrounded, by an isolating material, such as an oxide. Silicon dioxide (SiO.sub.2)or silicon nitride (Si.sub.3 N.sub.4) are examples of oxides commonly used for this purpose. Advantageously, the substantial isolation of the CCSD 102 helps ensure the preservation of electrical charge on the CCSD 102. Indeed, in accordance with a preferred embodiment, virtually no charge leakage occurs, and absent purposeful charge injection or drainage (described below), the charge

deposited on the charge carrying component will be preserved virtually indefinitely (for all practical purposes).

Indeed, the operation of device 100 is based on the ability of free charge to be preserved within the structure for a very long time. Free charge carriers can be introduced by either doping or from external sources. Charge can be introduced via hot electron injection through a thin tunneling-oxide into the CCSD 102 or removed by electron tunneling from the structure to the underlying substrate 103. These two processes can be controlled by applying appropriate potentials to gates 108 and 112 located above the injector 1 10 and drain 114 nodes respectively. These nodes can be formed by conventional MOS transistors or by other means such as a single-transistor silicon synapse. Once charge is resident on the CCSD 102 it will disperse evenly throughout the CCSD 102.

Various electrodes and gates, such as gates 108 and 112, will be referred to herein as being displaced adjacent to or in proximity with the CCSD 102. It will be appreciated that the terms 'adjacent' and 'proximity', are relative terms that necessarily depend upon the operation performed thereby. For example, in regard to the charge injector 104, the gates are spaced from the CCSD 102 by an oxide layer, which is thin enough to permit the transfer of charge carriers (either P-type or N-type) from the well 110 to the CCSD 102, in response to potential applied to the control gate 108.

To more particularly describe the injection and removal of charge to/from the CCSD 102, in order to control the quantity of charge carried on the charge-carrying component, a charge injector 104 is disposed adjacent to the CCSD 102 and is configured to controllably transfer charge to the CCSD 102 from an external source (not shown). Similarly, a drain 106 disposed adjacent to the CCSD 102 and is configured to controllably transfer charge away from the CCSD 102. The charge injector 104 and drain 106 of the preferred embodiment of the present invention are structurally similar to charge injectors and drains conventionally used in EEPROM technology.

The charge injector 104 includes a control gate 108 and a transistor 110, such as a MOSFET, disposed opposite the CCSD 102. The transistor 110 may be formed from a P-type well, with N-type material implanted, as illustrated in FIG. 3B. Applying an appropriate potential to the control gate 108 causes the transistor 110 to transfer charge (through hot electron injection) through the oxide layer surrounding the CCSD 102, to the CCSD. Similarly, a second control gate 112 is disposed in connection with the drain 106, wherein the application of a control potential to the control gate 112 control the operation of a drain transistor 114. Thus, through tunneling or otherwise, this causes charge accumulated and carried on the CCSD to be transferred away, by way of the drain transistor 114. The drain transistor 114 may be formed by an N-type well, with P-type materials implanted therein, as illustrated. Again, the basic structure and operation relating to the charge injection and charge drainage to/from the CCSD 102 is similar to that utilized in EEPROM technology, and for that reason it need not be further described herein.

To generate an output (simulating an axon), a charge sensor 116 disposed in proximity with a charge sensing location on the CCSD, and an output is provided and disposed in communication with the charge sensor. In practice, the charge sensor 116 may be implemented as a transistor that is responsive to charge concentrated in the charge sensing location. In this regard, the charge sensing location will operate much like the control gate 108 and 112 in operating transistors 110 and 114. As a result, the output delivers an electric signal that is indicative of the charge sensed by the charge sensor 116.

Although the structure, technology, and fabrication techniques of the CCSD 102, the charge injector 104 and the drain 106 of the preferred embodiment are similar to those

implemented EEPROM devices, the relative size of the CCSD 102, in comparison to surrounding devices (which will be discussed below) is much larger than the relative size proportion of an EEPROM. As will be more fully appreciated from the discussion that follows, the relatively large size of the CCSD 102 allows for controlled redistribution of the charge carried by the CCSD 102, in response to localized electric fields created by input devices, which simulate the input stimulus of synapses and synaptic sites of a biological neuron. Thus, the redistribution of electric charge carried on the CCSD 102 will necessarily effect the concentration of charge in the charge sensing location, and thus the output generated by the charge sensing node 116.

To illustrate one structural adaptation of the CCSD 102 and a configuration of synaptic inputs, reference is hereby made to FIG. 4. In this illustrated embodiment, the CCSD 102 is U-shaped and includes a plurality of synaptic sites 120. Each synaptic site 120 includes an input 122 and a weighting function or weighting coefficient 124. A preferred structure of various inputs 122 will be described in FIGS. 5A, 5B, and 5C. Suffice it to say that, for purposes of the inventive concepts disclosed herein, the present invention is not limited to a particular input device or structure. Also illustrated is the charge sensor 116, which is used to generate the output signal that is delivered via output 130.

Each of the various inputs 122 are derived either from system inputs, or from outputs of neighboring devices 100 (See processing elements 20 of FIG. 2). As previously mentioned, and as is generally known, the weighting function associated with a given input 122 alters the effect of that input 122. In this regard, a given weighting function may nullify a given input, by weighting it with a value of zero. Furthermore, the various weighting functions may be varied over time, as the device 100 is trained (e.g., simulated learning).

In operation, charge is delivered from the charge injector 104 to the CCSD 102. If all weighting functions/coefficients 124 are set to zero, such that no input is effective upon the CCSD 102, then the charge carried on the CCSD 102 will evenly distribute itself throughout the surface of the CCSD 102. However, as various inputs 122 are imparted (as electric fields)upon local areas of the CCSD 102, they will redistribute the charge in that local area, which will affect the overall distribution of charge. Thus, although the overall quantity of charge carried on the CCSD 102 may be constant, various changes in the inputs 122 and input weighting coefficients will affect the output, as sensed by sensor 116 and delivered to output (axon) 130."

The language reproduced above from Gorelik provides absolutely no teaching or suggestion of <u>nanowires</u> as taught by Applicant's invention. Nanowires are a fundamental claim limitation of Applicant's claim 7. Where are nanowires taught by Gorelik? Beyond this, it should also be noted that Gorelik is attempting to mimic a neuron and the applicant is describing a synapse element. A synapse is not a neuron.

The Applicant submits that the rejection to claim 7 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or

motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 7, including all of the claim limitations of the claim(s) from which claim 7 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that neither Gorelik nor McHardy provide any teaching or suggestion of molecular technology, including nanotechnology. Third, there is simply no teaching of all the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 7 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 7 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 7.

Regarding claim 8, the Examiner admitted that McHardy fails to teach that the semi-conducting molecular structures comprise semi-conducting nanoparticles. The Examiner stated that they are purely conducting structures in McHardy.

The Examiner asserted that Gorelik teaches wherein the semi-conducting molecular structures comprise semi-conducting nanoparticles. In support of this argument, the Examiner cited Gorelik: C 8 L 54 through C 10 L 63, where it discusses the charge carrying semiconductor device, which comprises semi-conducting molecular connections. The Examiner asserted that nanoparticles are the atoms and molecules maintaining connections at the nanometer scale, such as the atoms at the border of the n-type and p-type wells common in semi-conducting devices.

The Examiner argued that it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's and Gorelik's invention for the reasons stated above (referring to "regarding claim 2").

The Applicant respectfully disagrees with this assessment and submits that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 apply equally against the rejection to claim 7 under 35 U.S.C. 103. The Applicant also submits that all of the arguments against the rejection to claim 5 apply equally to the rejection to claim 7.

Regarding the Examiner's arguments that C 8 L 54 through C 10, L 63 of Gorelik teaches nanoparticles, the Applicant has reviewed this citation and the rest of Gorelik and cannot find any mention of nanoparticles as taught by Applicant's invention. Nanoparticles are devices based on molecular technology (e.g., nanotechnology) as taught by Applicant's invention. A portion of C 8 L 54 through C 10, L 63 of Gorelik is reproduced as follows below:

> "Having now described some fundamentals of artificial neural networks that are known in the prior art, reference is now made to FIGS. 3A and 3B, which illustrate the principal components of semiconductor device (generally designated as reference numeral 100) that simulates a biological neuron. FIG. 3A is a diagram that schematically illustrates the device

100, while FIG. 3B is a diagram that illustrates a cross-sectional representation of a semiconductor material. In accordance with the preferred embodiment of the present invention, a charge-carrying semiconductor device (CCSD) 102 is fabricated from semiconductor material (such as a polysilicon) and is disposed above a semiconductor substrate 103, for example a P-type substrate. The charge-carrying semiconductor device 102 is separated from the substrate 103, and substantially surrounded, by an isolating material, such as an oxide. Silicon dioxide (SiO.sub.2)or silicon nitride (Si.sub.3 N.sub.4) are examples of oxides commonly used for this purpose. Advantageously, the substantial isolation of the CCSD 102 helps ensure the preservation of electrical charge on the CCSD 102. Indeed, in accordance with a preferred embodiment, virtually no charge leakage occurs, and absent purposeful charge injection or drainage (described below), the charge deposited on the charge carrying component will be preserved virtually indefinitely (for all practical purposes).

Indeed, the operation of device 100 is based on the ability of free charge to be preserved within the structure for a very long time. Free charge carriers can be introduced by either doping or from external sources. Charge can be introduced via hot electron injection through a thin tunneling-oxide into the CCSD 102 or removed by electron tunneling from the structure to the underlying substrate 103. These two processes can be controlled by applying appropriate potentials to gates 108 and 112 located above the injector 1 10 and drain 114 nodes respectively. These nodes can be formed by conventional MOS transistors or by other means such as a single-transistor silicon synapse. Once charge is resident on the CCSD 102 it will disperse evenly throughout the CCSD 102.

Various electrodes and gates, such as gates 108 and 112, will be referred to herein as being displaced adjacent to or in proximity with the CCSD 102. It will be appreciated that the terms `adjacent` and `proximity`, are relative terms that necessarily depend upon the operation performed thereby. For example, in regard to the charge injector 104, the gates are spaced from the CCSD 102 by an oxide layer, which is thin enough to permit the transfer of charge carriers (either P-type or N-type) from the well 110 to the CCSD 102, in response to potential applied to the control gate 108.

To more particularly describe the injection and removal of charge to/from the CCSD 102, in order to control the quantity of charge carried on the charge-carrying component, a charge injector 104 is disposed adjacent to the CCSD 102 and is configured to controllably transfer charge to the CCSD 102 from an external source (not shown). Similarly, a drain 106 disposed adjacent to the CCSD 102 and is configured to controllably transfer charge away from the CCSD 102. The charge injector 104 and drain 106 of the preferred embodiment of the present invention are structurally similar to charge injectors and drains conventionally used in EEPROM technology.

The charge injector 104 includes a control gate 108 and a transistor 110, such as a MOSFET, disposed opposite the CCSD 102. The transistor 110 may be formed from a P-type well, with N-type material implanted, as illustrated in FIG. 3B. Applying an appropriate potential to the control gate 108 causes the transistor 110 to transfer charge (through hot electron injection) through the oxide layer surrounding the CCSD 102, to the CCSD. Similarly, a second control gate 112 is disposed in connection with the drain 106, wherein the application of a control potential to the control gate 112 control the operation of a drain transistor 114. Thus, through tunneling or otherwise, this causes charge accumulated and carried on the CCSD to be transferred away, by way of the drain transistor 114. The drain transistor 114 may be formed by an N-type well, with P-type materials implanted therein, as illustrated. Again, the basic structure and operation relating to the charge injection and

charge drainage to/from the CCSD 102 is similar to that utilized in EEPROM technology, and for that reason it need not be further described herein.

To generate an output (simulating an axon), a charge sensor 116 disposed in proximity with a charge sensing location on the CCSD, and an output is provided and disposed in communication with the charge sensor. In practice, the charge sensor 116 may be implemented as a transistor that is responsive to charge concentrated in the charge sensing location. In this regard, the charge sensing location will operate much like the control gate 108 and 112 in operating transistors 110 and 114. As a result, the output delivers an electric signal that is indicative of the charge sensed by the charge sensor 116.

Although the structure, technology, and fabrication techniques of the CCSD 102, the charge injector 104 and the drain 106 of the preferred embodiment are similar to those implemented EEPROM devices, the relative size of the CCSD 102, in comparison to surrounding devices (which will be discussed below) is much larger than the relative size proportion of an EEPROM. As will be more fully appreciated from the discussion that follows, the relatively large size of the CCSD 102 allows for controlled redistribution of the charge carried by the CCSD 102, in response to localized electric fields created by input devices, which simulate the input stimulus of synapses and synaptic sites of a biological neuron. Thus, the redistribution of electric charge carried on the CCSD 102 will necessarily effect the concentration of charge in the charge sensing location, and thus the output generated by the charge sensing node 116.

To illustrate one structural adaptation of the CCSD 102 and a configuration of synaptic inputs, reference is hereby made to FIG. 4. In this illustrated embodiment, the CCSD 102 is U-shaped and includes a plurality of synaptic sites 120. Each synaptic site 120 includes an input 122 and a weighting function or weighting coefficient 124. A preferred structure of various inputs 122 will be described in FIGS. 5A, 5B, and 5C. Suffice it to say that, for purposes of the inventive concepts disclosed herein, the present invention is not limited to a particular input device or structure. Also illustrated is the charge sensor 116, which is used to generate the output signal that is delivered via output 130.

Each of the various inputs 122 are derived either from system inputs, or from outputs of neighboring devices 100 (See processing elements 20 of FIG. 2). As previously mentioned, and as is generally known, the weighting function associated with a given input 122 alters the effect of that input 122. In this regard, a given weighting function may nullify a given input, by weighting it with a value of zero. Furthermore, the various weighting functions may be varied over time, as the device 100 is trained (e.g., simulated learning).

In operation, charge is delivered from the charge injector 104 to the CCSD 102. If all weighting functions/coefficients 124 are set to zero, such that no input is effective upon the CCSD 102, then the charge carried on the CCSD 102 will evenly distribute itself throughout the surface of the CCSD 102. However, as various inputs 122 are imparted (as electric fields)upon local areas of the CCSD 102, they will redistribute the charge in that local area, which will affect the overall distribution of charge. Thus, although the overall quantity of charge carried on the CCSD 102 may be constant, various changes in the inputs 122 and input weighting coefficients will affect the output, as sensed by sensor 116 and delivered to output (axon) 130."

The language reproduced above from Gorelik provides absolutely no teaching or suggestion of nanoparticles as taught by Applicant's invention. Nanoparticles are a fundamental claim limitation of Applicant's claim 8. The charge carrying semiconductor device of Gorelik does not comprise semi-conducting molecular connections as taught by Applicant's invention. The semi-conducting molecular connections of Applicant's invention are disposed in a solution. The Examiner asserted that nanoparticles are the atoms and molecules maintaining connections at the nanometer scale, such as the atoms at the border of the n-type and p-type wells common in semi-conducting devices. Gorelik does not explain, however, how such atoms at the border of the n-type and p-type wells common in semi-conducting devices can be utilized to construct nanometer scale devices, such as physical neural network of Applicant's invention. The use of n-type and p-type wells does not involve molecular technology (including nanotechnology) as taught by Applicant's specification and claims, but instead relates to a teaching of the fabrication and processes for CMOS technology (which is not nanotechnology). The "atoms and molecules maintaining connections" as indicated by the Examiner involves CMOS fabrication and is simply not a teaching of molecular technology (nanotechnology) as taught by Applicant's invention.

The Applicant submits that the rejection to claim 8 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 8, including all of the claim limitations of the claim(s) from which claim 8 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that neither Gorelik nor McHardy provide any teaching or suggestion of molecular technology, including

nanotechnology. Third, there is simply no teaching of <u>all</u> the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 8 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 8 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 8.

McHardy, Nunally

Claims 11-13 were rejected by the Examiner under 35 U.S.C. 103(a) as being unpatentable over McHardy as applied to claims 1 and 9 above, and further in view of Nunally (U.S. Patent No. 5,615,305).

Regarding claim 11, the Examiner admitted that McHardy fails to teach that the physical neural network wherein at least one generated pulse from said at least

one pre-synaptic electrode and at least one generated pulse from said at least one post-synaptic electrode is determinative of synaptic update values thereof.

The Examiner asserted that Nunally teaches that at least one generated pulse from said at least one pre-synaptic electrode at least one generated pulse form said at least one post-synaptic electrode is determinative of synaptic update values thereof. In support of this argument, the Examiner cited Nunally, C 1-7, particularly C 4, L 58 through C 5, L 8).

The Examiner asserted that being from the same field of endeavor, physical neurons (of artificial neural systems) and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's electrochemical synapse, asserting that this provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Nunally's pulse driven training mechanism to be able to update vast amounts of synaptic weights of the network asynchronously with little computational requirements. In support of this argument, the Examiner cited Nunally: C 1, L 53-67.

The Applicant respectfully disagrees with this assessment and notes that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 (with respect to McHardy) apply equally against the rejection to claim 11 under 35 U.S.C. 103. As indicated previously, McHardy provides no teaching for nanometer scale components, nanotechnology and molecular technology, particularly in the dipole-induced aggregation of nanoparticles. Also, as indicated previously, McHardy does not provide for a teaching of a neural network, but teaches only a synapse for use in a neural network, rather than a neural network itself. Similarly, Nunally at C 1-7, and particularly C 4, L 58 through C 5, L 8, does NOT provide for any teaching of <u>molecular technology</u> (including <u>nanotechnology</u>) <u>as taught by Applicant's specification and claims</u>. FIGS. 1-12 describe a neural system based on very large

scale (as opposed to nanometer-scale) integrated components such as logic gates, MOS, PMOS, transistors and the like.

Applicant's background section (paragraphs 0013-00150 specifically describes the problems with hardware-based neural systems such as Nunally, as follows:

> "The implementation of neural network systems has lagged somewhat behind their theoretical potential due to the difficulties in building neural network hardware. This is primarily because of the large numbers of neurons and weighted connections required. The emulation of even of the simplest biological nervous systems would require neurons and connections numbering in the millions and/or billions.
>
> Due to the difficulties in constructing such highly interconnected processors, currently available neural network hardware systems have not approached this level of complexity. Another disadvantage of hardware systems is that they typically are often custom designed and configured to implement one particular neural network architecture and are not easily, if at all, reconfigurable in implementing different architectures. A true physical neural network chip, with the learning abilities and connectivity of a biological network, has not yet been designed and successfully implemented.
>
> The problem with a pure hardware implementation of a neural network utilizing existing technology is the inability to physically form a great number of connections and neurons. On-chip learning can exist, but the size of the network is limited by digital processing methods and associated electronic circuitry. One of the difficulties in creating true physical neural networks lies in the highly complex manner in which a physical neural network must be designed and constructed. The present inventor believes that solutions to creating a true physical and artificial neural network lie in the use of nanotechnology and the implementation of a novel form of variable connections."

Nunally represents an example of a traditional hardware (non-nanotechnology/molecular technology) approach to neural networks. As indicated above, such traditional approaches are difficult to construct, and in fact as the background section indicates "a true physical neural network chip, with the learning abilities and connectivity of a biological network, has not yet been designed and successfully implemented." The bottom line is that Nunally does not teach nanotechnology/molecular technology, and in fact due to the use of large scale components such as transistors, PMOS, logic devices, and so forth as a basis for building a neural network, teaches away from nanometer-scale components as a basis for forming a true physical neural network such as Applicant's invention.

The Applicant submits that the rejection to claim 11 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 11, including all of the claim limitations of the claim(s) from which claim 11 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that neither Nunally nor McHardy provide any teaching or suggestion of molecular technology, including nanotechnology. Third, there is simply no teaching of <u>all</u> the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 11 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 11 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 11.

Regarding claim 12, the Examiner admitted that McHardy fails to teach the neural network of claim 9 wherein a shape of at least one generated pulse from said at least one pre-synaptic electrode and at least one generated pulse from said at least one post-synaptic electrode is determinative of synaptic update values thereof.

The Examiner asserted that Nunally teaches a shape of at least one generated pulse from said at least one pre-synaptic electrode and at least one generated pulse from said at least one post-synaptic electrode is determinative of synaptic update values. In support of this argument, the Examiner cited Nunally: C 1-7, particularly C 2, L 40-46 as well as C 4, L 1-21). The Examiner argued that it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's and Nunally's invention for the reasons stated above (referring to "regarding claim 12").

The Applicant respectfully disagrees with this assessment and notes that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 (with respect to McHardy) apply equally against the rejection to claim 12 under 35 U.S.C. 103. Additionally, the arguments presented above against the rejection to claim 9 under 35 U.S.C. 102 (with respect to McHardy) apply equally against the rejection to claim 12 under 35 U.S.C. 103.

As indicated previously, McHardy provides no teaching for nanometer scale components, nanotechnology and molecular technology. Also, as indicated previously, McHardy does not provide for a teaching of a neural network, but teaches only a synapse for use in a neural network, rather than a neural network itself. Similarly, Nunally at C 1-7, particularly C 2, L 40-46 as well as C 4, L 1-21,

do NOT provide for any teaching of molecular technology (including nanotechnology), particularly the dipole-induced aggregation of nanoparticles as taught by Applicant's specification and claims.

The Applicant submits that the rejection to claim 12 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 12, including all of the claim limitations of the claim(s) from which claim 12 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that neither Nunally nor McHardy provide any teaching or suggestion of molecular technology, including nanotechnology. Third, there is simply no teaching of all the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 12 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's

invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 12 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 12.

Regarding claim 13, the Examiner admitted that McHardy fails to teach an adaptive neural network which is trainable based on said at least one generated pulse across said at least one pre-synaptic electrode and at least one generated pulse across said at least one post-synaptic electrode.

The Examiner argued that Nunally teaches an adaptive neural network which is trainable based on said at least one generated pulse across said at least one pre-synaptic electrode and at least one generated pulse across said at least one post-synaptic electrode. In support of this argument, the Examiner cited Nunally C 1-7, particularly C 4, L 58 through C 5, L 8. The Examiner asserted that it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's and Nunally's invention for the reasons stated above (referring to "regarding claim 12").

The Applicant respectfully disagrees with this assessment and notes that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 (with respect to McHardy) apply equally against the rejection to claim 13 under 35 U.S.C. 103. Additionally, the arguments presented above against the rejection to claim 12 above apply equally against the rejection to claim 13 under 35 U.S.C. 103.

As indicated previously, McHardy provides no teaching for nanometer scale components, nanotechnology and molecular technology. Also, as indicated previously, McHardy does not provide for a teaching of a neural network, but teaches only a synapse for use in a neural network, rather than a neural network itself. Similarly, Nunally at C 1-7, particularly C 4, L 58 through C 5, L 8 does NOT

provide for any teaching of molecular technology (including nanotechnology), particularly the dipole-induced aggregation of nanoparticles as taught by Applicant's specification and claims. Instead, C 4, L 58 through C 5, L 8 refers to much larger components and devices such as AND gates, OR gates, PMOS, NMOS transistors, lock out gate, capacitors, and the like. Such components do not provide for a teaching of molecular technology-based (including nanotechnology) components used to create a physical neural network. Because neither Nunally nor McHardy teach molecular technology and nanotechnology as taught by Applicant's invention, and in fact teach away from this technology, it would be improper to use McHardy and Nunally as a basis for arguing that such devices teach the molecular technology (including nanotechnology) of Applicant's invention.

The Applicant submits that the rejection to claim 13 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 13, including all of the claim limitations of the claim(s) from which claim 13 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that neither Nunally nor McHardy provide any teaching or suggestion of molecular technology, including nanotechnology. Third, there is simply no teaching of all the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are

rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 13 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 13 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 13.

McHardy, Widrow

Claim 16 was rejected by the Examiner under 35 U.S.C. 103(a) as being unpatentable over McHardy as applied to claim 1 above, and further in view of Widrow (U.S. Patent No. 3,222,654).

The Examiner admitted that McHardy fails to teach the physical neural network of claim 1 wherein a variable increase in a frequency of said electrical field across said connection gap strengthens said molecular conducting connections thereof.

The Examiner argued, however, that Widrow teaches the ability of a memistor to be used as a multiplier or a linear modulator with the appropriate addition of copper circuitry. The Examiner cited C 10, L 65 through C 11, L 10 of Widrow in support of this argument. The Examiner asserted that an increase in frequency f_1 corresponds to the increase in the connection gap strength. The Examiner asserted that changing the frequency of the alternating current is still within the scope of the

disclosed alternating current of Widrow, arguing that this is in directed correlation to the rate of deposition of the electroplating.

The Examiner also argued that being from the same field of endeavor, physical neurons (of artificial neural systems) and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's electrochemical synapse, asserting that his provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Widrow's method of electrochemical plating. The Examiner argued that McHardy can be seen as a closer approximation to the current state of the art offering miniaturization, asserting that this provides the ability to use many of these neurons in parallel with little worry for space constraint.

The Applicant respectfully disagrees with this assessment and notes that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 (with respect to McHardy) apply equally against the rejection to claim 16 under 35 U.S.C. 103.

The invention described by the Applicant does not, in any way, utilize an electrochemical process. The entire effect of McHardy and Widrow requires the migration of metal ions. To argue that the combination of McHardy and Widrow makes obvious the applicants invention disregards that a completely different physical process is being utilized.

Regarding the use of increasing an alternating electric field across the connection gap, the Examiner has disregarded the fact that the invention disclosed by McHardy will not work with an alternating electric field. McHardy states this in the 5th paragraph of the Description of Related Art that:

"Metal migration is an electrochemical process related to electroplating. Metal migration takes place between conductors in an active electronic circuit in the presence of a moisture film. Under the influence of a DC voltage, metal ions dissolve from the positive conductor (the anode). The dissolved ions migrate

through the moisture film (the electrolyte) and plate out on the negative conductor (the cathode). The deposit often takes the form of metallic whiskers which eventually reach the anode and create an ohmic contact."

The AC voltage used in Widrow could not be applied to McHardy because it would have been obvious to one of ordinary skill at the time of Applicant's invention **that metal migration cannot be attained with an AC electric current**. Based on this fact and also that both Widrow and McHardy describe a device that operates on completely different physical phenomena, The Applicant submits that the rejection to claim 16 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 16, including all of the claim limitations of the claim(s) from which claim 16 depends. Second, there is not a reasonable expectation of success for such a combination, particularly in light of the fact that Widrow and McHardy do NOT provide any teaching or suggestion of molecular technology, including nanotechnology. In particular, Widrow provides no teaching of nanotechnology AND neural networks. Third, there is simply no teaching of <u>all</u> the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in

these references in order to yield the invention as claimed. The rejection to claim 16 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 16 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 16.

McHardy, Gorelik, Widrow

Claims 17-18 were rejected by the Examiner under 35 U.S.C. 103(a) as being unpatentable over McHardy, in view of Gorelik, and further in view of Widrow.

Regarding claim 17, the Examiner argued that McHardy teaches a physical neural network (citing McHardy: C 1-6, particularly C 1, L 8-10, and C 2, L 45-54), comprising:

a connection network (the Examiner argued that neural networks are inherently a connection network, asserting that proper operation requires numerous weighted connections and other requirements) comprising a plurality of molecular conducting connections suspended within a connection gap (citing McHardy: C 3, L 43-45) formed between at least one input electrode and at least one output electrode (citing McHardy: C 1-6, particularly C 1, L 44 through C 2, 54, where it discusses the roles of the anode and the cathode), wherein at least one molecular connection of said plurality of molecular conducting connections can be strengthened or weakened to an application of an electric field across said connection gap (citing McHardy: C 1-6, particularly C 1, L 44 through C 2, 54; also

C 3, L 44 through C 4, L 7; arguing that strengthening or weakening corresponds to the amount of whiskers present in the interconnect channel, likewise the conductivity of that channel);

a plurality of physical synapses formed from said molecular conducting connections of said connection network (citing McHardy: C 1-6, particularly C 2, L 45-54).

The Examiner admitted that McHardy fails to teach wherein the physical neural network comprises a gate located adjacent said connection gap and which is insulated from said connection network; and wherein a variable increase in a frequency of said electrical field across said connection gap strengthens said molecular conducting connections thereof.

The Examiner argued, however, that Gorelik teaches wherein the physical neural network further comprises a gate located adjacent said connection gap, insulated from electrical contact by an insulation layer (citing Gorelik: C 8 L 54 through C 9, L 35).

The Examiner stated that being from the same field of endeavor, physical neurons (arguing "of artificial neural systems") and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's electrochemical synapse which provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Gorelik's semi conducting method of an approximation to an artificial biological neurons with this insulation layer so as to maintain charge within the charge carrying layer indefinitely, thus allowing minimal leakage. The Examiner cited Gorelik: C 8 L 54 through C 9, L 35 in support of this argument. The Examiner asserted that combining the electrochemical synapse with a semi conducing signaling device allows for a greater flexibility in the application of the physical neural network, where it is to be implemented in different

environments for different needs of fault-tolerance or physical structure or electrical requirements.

The Examiner argued that Widrow teaches the ability of a memistor to be used as a multiplier or a linear modulator with the appropriate addition of copper circuitry. The Examiner cited Widrow C 10, L 65 through C 11, L 10 in support of this argument. The Examiner asserted that an increase in frequency f_1 corresponds to the increase in the connection gap strength. The Examiner asserted that changing the frequency of the alternating current is still within the scope of the disclosed alternating current of Widrow, arguing that this is in directed correlation to the rate of deposition of the electroplating.

The Examiner also argued that being from the same field of endeavor, physical neurons (of artificial neural systems) and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's electrochemical synapse, asserting that his provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Widrow's method of electrochemical plating. The Examiner argued that McHardy can be seen as a closer approximation to the current state of the art offering miniaturization, asserting that this provides the ability to use many of these neurons in parallel with little worry for space constraint.

The Applicant respectfully disagrees with this assessment and notes that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 (with respect to McHardy) apply equally against the rejection to claim 17 under 35 U.S.C. 103. Additionally the arguments presented above against the rejection to claims 2-8 with respect to McHardy/Gorelik apply equally against the rejection to claim 17. Also, the arguments presented above against the rejection to claim 16 with respect to McHardy/Widrow apply equally against the rejection to claim 17.

The Applicant submits that the rejection to claim 17 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 17, including all of the claim limitations of the claim(s) from which claim 17 depends. Both McHardy and Widrow disclose a completely difference physical phenomena. Further, the "gate" of Gorelik is in reference to a neural node, not a synapse. Anybody of ordinary skill in the art at the time of the Applicant's invention would have been aware that a neuron is not a synapse. The AC voltage used in Widrow could not be applied to McHardy because it would have been obvious to one of ordinary skill at the time of Applicant's invention that metal migration cannot be attained with an AC electric current.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 17 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 17 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 17.

Regarding claim 18, the Examiner argued that McHardy teaches wherein the molecular electrically conducting connections comprise molecular electrically conducting structures suspended with a non-electrically conducting solution. In support of this argument, the Examiner cited C 6, L 30-46, arguing that non-electrically conducting solution is described herein as the multi-layer thin film technology utilizing polymer dielectrics.

The Applicant respectfully disagrees with this assessment and notes that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 (with respect to McHardy) apply equally against the rejection to claim 18 under 35 U.S.C. 103. Additionally the arguments presented above against the rejection to claims 2-8 with respect to McHardy/Gorelik apply equally against the rejection to claim 18. Also, the arguments presented above against the rejection to claim 16 with respect to McHardy/Widrow apply equally against the rejection to claim 18

The Applicant submits that the rejection to claim 18 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 18, including all of the claim limitations of the claim(s) from which claim 18 depends. Second, there is not a reasonable expectation of success for such a combination. How could there be a reasonable expectation for such a combination when Widrow describes an electroplating process having no relation the dipole-induced aggregation effect described by the applicant, McHardy describes a metal migration process having no relation the dipole-induced aggregation effect described by the applicant, and Gorelik relates to a teaching of the fabrication and

processes for CMOS technology (but not molecular nanotechnology) intended for the emulation of a neural node, not a synapse. Third, there is simply no teaching of all the claim limitations by the references when combined as argued by the Examiner. In addition, the examiner has not provided an explanation for how a polymer dielectric can be considered a solution capable of suspending nanoparticles and allowing the nanoparticles to move around.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 18 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 18 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 18.

McHardy, Gorelik, Widrow, Nunally

Claim 20 was rejected by the Examiner under 35 U.S.C. 103(a) as being unpatentable over McHardy, in view of Gorelik, and further in view of Widrow, and further in view of Nunally.

Regarding claim 20, the Examiner argued that McHardy teaches a physical neural network (citing McHardy: C 1-6, particularly C 1, L 8-10, and C 2, L 45-54), comprising:

a connection network (the Examiner argued that neural networks are inherently a connection network, asserting that proper operation requires numerous weighted connections and other requirements) comprising a plurality of molecular conducting connections suspended within a connection gap (citing McHardy: C 3, L 43-45) formed between at least one input electrode and at least one output electrode (citing McHardy: C 1-6, particularly C 1, L 44 through C 2, 54, where it discusses the roles of the anode and the cathode), wherein at least one molecular connection of said plurality of molecular conducting connections can be strengthened or weakened to an application of an electric field across said connection gap (citing McHardy: C 1-6, particularly C 1, L 44 through C 2, 54; also C 3, L 44 through C 4, L 7; arguing that strengthening or weakening corresponds to the amount of whiskers present in the interconnect channel, likewise the conductivity of that channel);

a plurality of physical synapses formed from said molecular conducting connections of said connection network (citing McHardy: C 1-6, particularly C 2, L 45-54);

wherein a resistance of said molecular conducting connections bridging said at least one pre-synaptic electrode and said at least one post-synaptic electrode is a function of a prior electric field across said at least one pre-synaptic electrode and said at least post-synaptic electrode. In support of this argument, the Examiner cited C 1, L 29 through C 2, L 4 of McHardy where it discusses Bernard Widrow's

"memistor's" capability to regulate resistance, arguing that it does this through the application of an electrical field, and further arguing that immediately following this discussion where it describes the process of metal migration, and how metallic whiskers grow to create an ohmic [arguing "resistive"] contact between electrodes when a DC voltage is applies, the whiskers being the molecular conducting connections.

The Examiner admitted that McHardy fails to teach wherein the physical neural network comprises a gate located adjacent said connection gap, (insulated from electrical contact by an insulation layer?), wherein a variable increase in a frequency of said electrical field across said connection gap strengthens said molecular conducting connections thereof; and wherein the adaptive neural network is trainable based on said at least one generated pulse across said at least one pre-synaptic electrode and at least one generated pulse across said at least one post-synaptic electrode.

The Examiner argued that Gorelik teaches wherein the physical neural network further comprises a gate located adjacent said connection gap, insulated from electrical contact by an insulation layer. The Examiner cited Gorelik C 8, L 54 through C 9, L 35 in support of this argument. [NOTE: the Applicant notes that claim 20 does not include the claim limitation of "insulated from electrical contact by an insulation layer"]

The Examiner argued that that Gorelik teaches wherein the physical neural network further comprises a gate located adjacent said connection gap, insulated from electrical contact by an insulation layer (citing Gorelik: C 8 L 54 through C 9, L 35).

The Examiner stated that being from the same field of endeavor, physical neurons (arguing "of artificial neural systems") and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at

the time of Applicant's invention to combine McHardy's electrochemical synapse which provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Gorelik's semi conducting method of an approximation to an artificial biological neurons with this insulation layer so as to maintain charge within the charge carrying layer indefinitely, thus allowing minimal leakage. The Examiner cited Gorelik: C 8 L 54 through C 9, L 35 in support of this argument. The Examiner asserted that combining the electrochemical synapse with a semiconducting signaling device allows for a greater flexibility in the application of the physical neural network, where it is to be implemented in different environments for different needs of fault-tolerance or physical structure or electrical requirements.

The Examiner argued that Widrow teaches the ability of a memistor to be used as a multiplier or a linear modulator with the appropriate addition of copper circuitry. The Examiner cited Widrow C 10, L 65 through C 11, L 10 in support of this argument. The Examiner asserted that an increase in frequency f_1 corresponds to the increase in the connection gap strength. The Examiner asserted that changing the frequency of the alternating current is still within the scope of the disclosed alternating current of Widrow, arguing that this is in directed correlation to the rate of deposition of the electroplating.

The Examiner also argued that being from the same field of endeavor, physical neurons (of artificial neural systems) and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of Applicant's invention to combine McHardy's electrochemical synapse, asserting that his provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Widrow's method of electrochemical plating. The Examiner argued that McHardy can be seen as a closer approximation to the current state of the art offering miniaturization, asserting that this provides

the ability to use many of these neurons in parallel with little worry for space constraint.

The Examiner asserted that Nunally teaches an adaptive neural network which is trainable based on said at least one generated pulse across said at least one pre-synaptic electrode and at least one generated pulse across said at least one post-synaptic electrode. In support of this argument, the Examiner cited Nunally, C 1-7, particularly C 4, L 58 through C 5, L 8).

The Examiner asserted that being from the same field of endeavor, physical neurons (arguing "of artificial neural systems") and synapses thereof to mimic the behavior of biological neurons, it would have been obvious to one of ordinary skill at the time of the Applicant's invention to combine McHardy's electrochemical synapse, asserting that this provides easy miniaturization of the vast amounts of neurons needed to simulate biological neurons with Nunally's pulse driven training mechanism to be able to update vast amounts of synaptic weights of the network asynchronously with little computational requirements (citing Nunally: C 1, L 53-67).

The Applicant respectfully disagrees with this assessment and notes that the arguments presented above against the rejection to claim 1 under 35 U.S.C. 102 (with respect to McHardy) apply equally against the rejection to claim 20 under 35 U.S.C. 103. Additionally the arguments presented above against the rejection to claims 2-8 with respect to McHardy/Gorelik apply equally against the rejection to claim 20. Also, the arguments presented above against the rejection to claim 16 with respect to McHardy/Widrow apply equally against the rejection to claim 20. The Applicant further submits that the arguments presented above against the rejection to claims 11-13 with respect fo McHardy/Nunally apply equally against the rejection to claim 20.

The Applicant submits that the rejection to claim 20 fails under all three prongs of the aforementioned prima facie obviousness test. First, there is no

suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings as argued by the Examiner to teach each and every claim limitation of Applicant's claim 20, including all of the claim limitations of the claim(s) from which claim 20 depends. Second, there is not a reasonable expectation of success for such a combination. How could there be a reasonable expectation for such a combination when Widrow does not teach nanotechnology or neural networks, Both McHardy and Widrow disclose a completely difference physical phenomena. The AC voltage used in Widrow could not be applied to McHardy because it would have been obvious to one of ordinary skill at the time of Applicant's invention that metal migration cannot be attained with an AC electric current. McHardy does not provide for a teaching of nanometer scale components, and Gorelik relates to a teaching of the fabrication and processes for CMOS technology (but not molecular nanotechnology) Intended to emulate a neural node, not a synapse. Anybody of ordinary skill in the art at the time of the applicant's invention would have been aware that a neuron is not a synapse. Nunally does not provide for any teaching of molecular technology (including nanotechnology) as taught by Applicant's specification and claims. Instead, Nunally refers to much larger components and devices such as AND gates, OR gates, PMOS, NMOS transistors, lock out gate, capacitors, and the like. Third, there is simply no teaching of all the claim limitations by the references when combined as argued by the Examiner.

Regarding the issue of motivation, the Applicant reminds the Examiner that the language of the references may not taken out of context and combined without motivation, in effect producing the words of the claims (and sometimes, not even the words or concepts of the claims), without their meaning or context. The resultant combination would not yield the invention as claimed. The claims are rejected under 35 U.S.C. §103(a) and no showing has been made to provide the motivation as to why one of skill in the art would be motivated to make such a

combination, and further fails to provide the teachings necessary to fill the gaps in these references in order to yield the invention as claimed. The rejection to claim 20 under 35 U.S.C. §103(a) has provided no more motivation than to simply point out the individual words of the Applicant's claims among the references, but without the reason and result as provided in the Applicant's claims and specification, and without reason as to why and how the references could provide the Applicant's invention as claimed. Hindsight cannot be the basis for motivation, which is not sufficient to meet the burden of sustaining a 35 U.S.C. §103(a) rejection.

Based on the foregoing, the Applicant submits that the rejection to claim 20 has been traversed. The Applicant therefore respectfully requests withdrawal of the rejection to claim 20.

IV. Conclusion

In view of the foregoing discussion, the Applicant has responded to each and every rejection of the Official Action. The Applicant has clarified the structural distinctions of the present invention. Applicant respectfully requests the withdrawal of the rejections under 35 U.S.C. §103 based on the preceding remarks. Reconsideration and allowance of Applicant's application is also respectfully solicited.

Should there be any outstanding matters that need to be resolved, the Examiner is respectfully requested to contact the undersigned representative to conduct an interview in an effort to expedite prosecution in connection with the present application.

Respectfully submitted,

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